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(56) Documents Cited
GB 2337645 A
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US 4654629 A
US 4298869 A

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(54) Abstract Title
LED lighting unit

(57) A lighting unit comprises an array of LEDs 17 wherein the array comprises two or more groups of LEDs connected so that in the event of the failure of one group the or each further group will continue to operate. The lighting unit further comprises current-limiting resistors 21, voltage regulators 24, 25, short circuit 27 and thermal overload 28 protection, a bridge rectifier 26 and a ceramic connection block (9, figure 2). The two or more groups of LEDs are connected in parallel and each group comprises cells containing a plurality of LEDs connected in series or parallel. The LEDs within the array are arranged to be planar in a series of concentric bands with an axis of illumination (13, 14, 15 figure 3) extending outwards of the plane, wherein the axis of illumination of each band is angled outwards with respect to the axis of illumination of an adjacent band closer to the centre of the array. The angle of divergence may be in the range from 4 to 8 degrees.

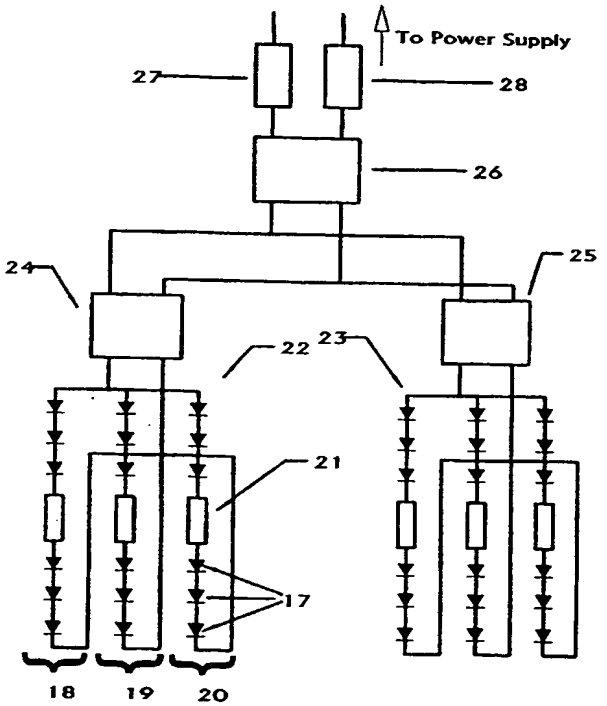

Figure 4

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The claims were filed later than the filing date but within the period prescribed by Rule 25(1) of the Patents Rules 1995.

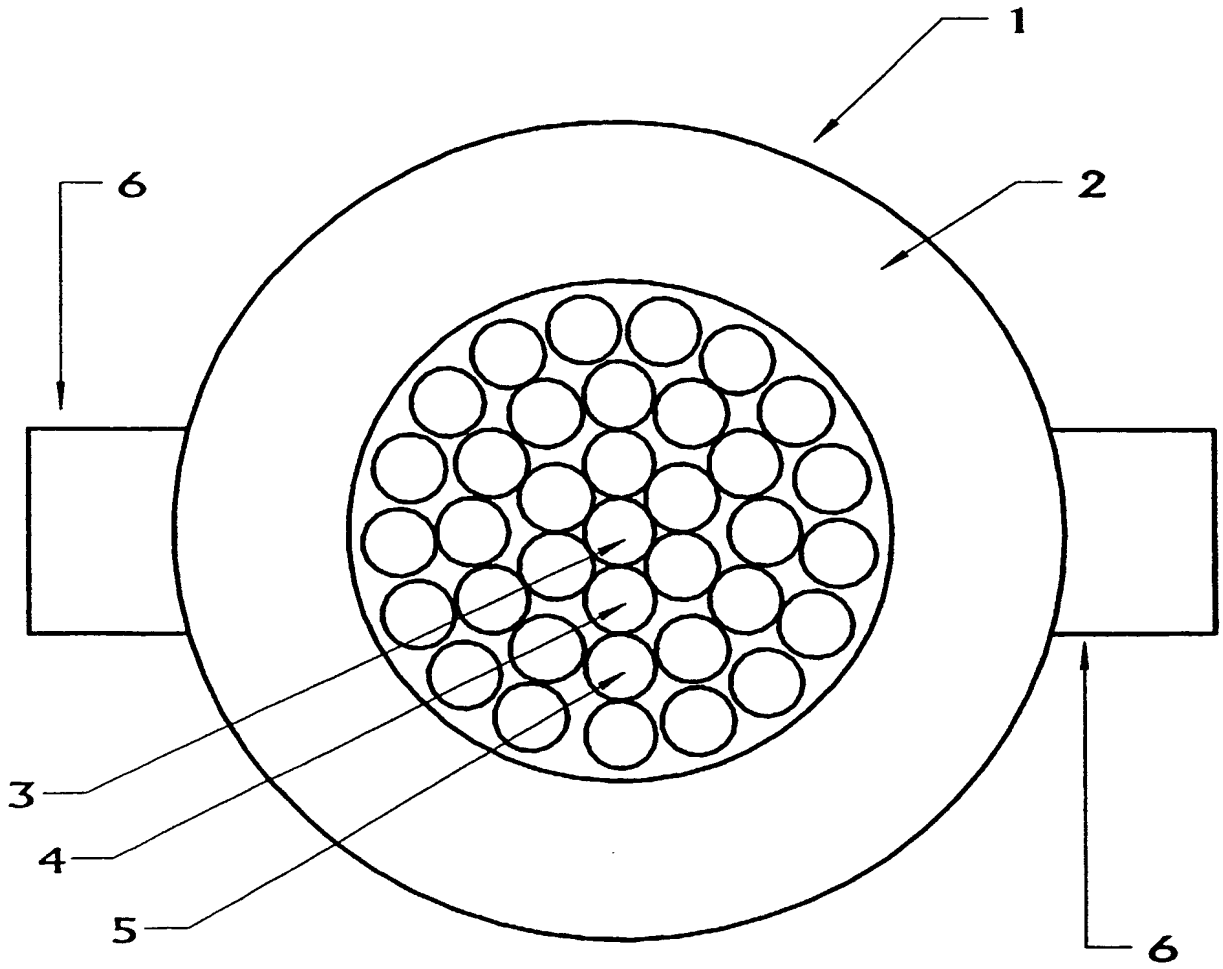

Figure 1

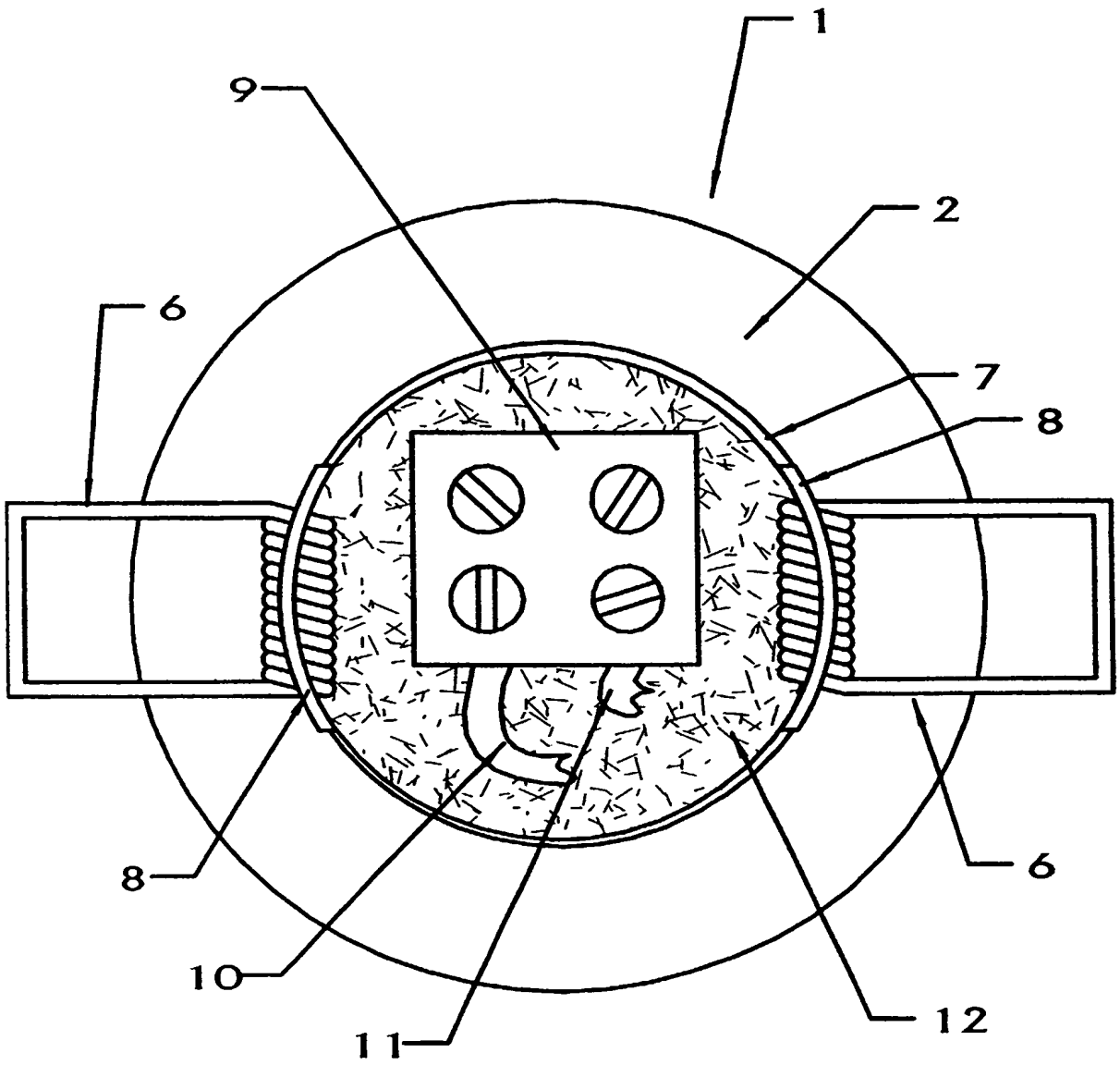

Figure 2

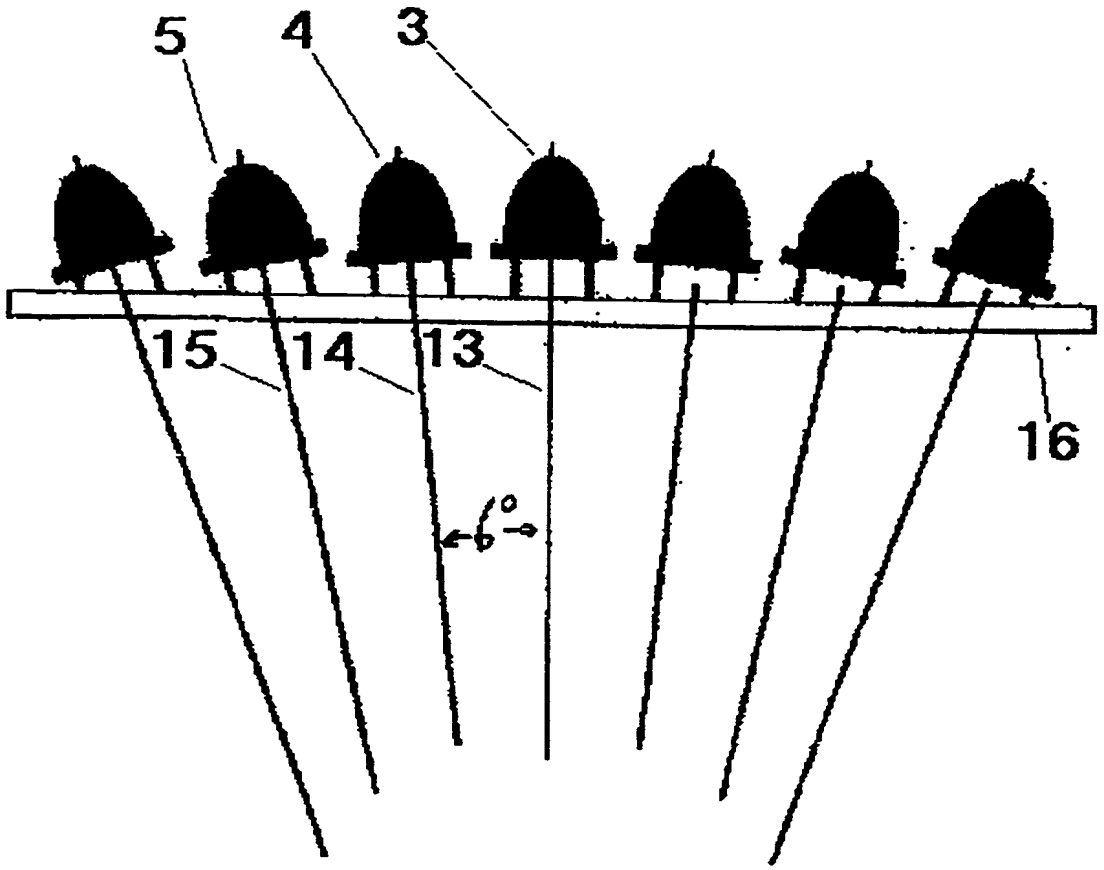

Figure 3

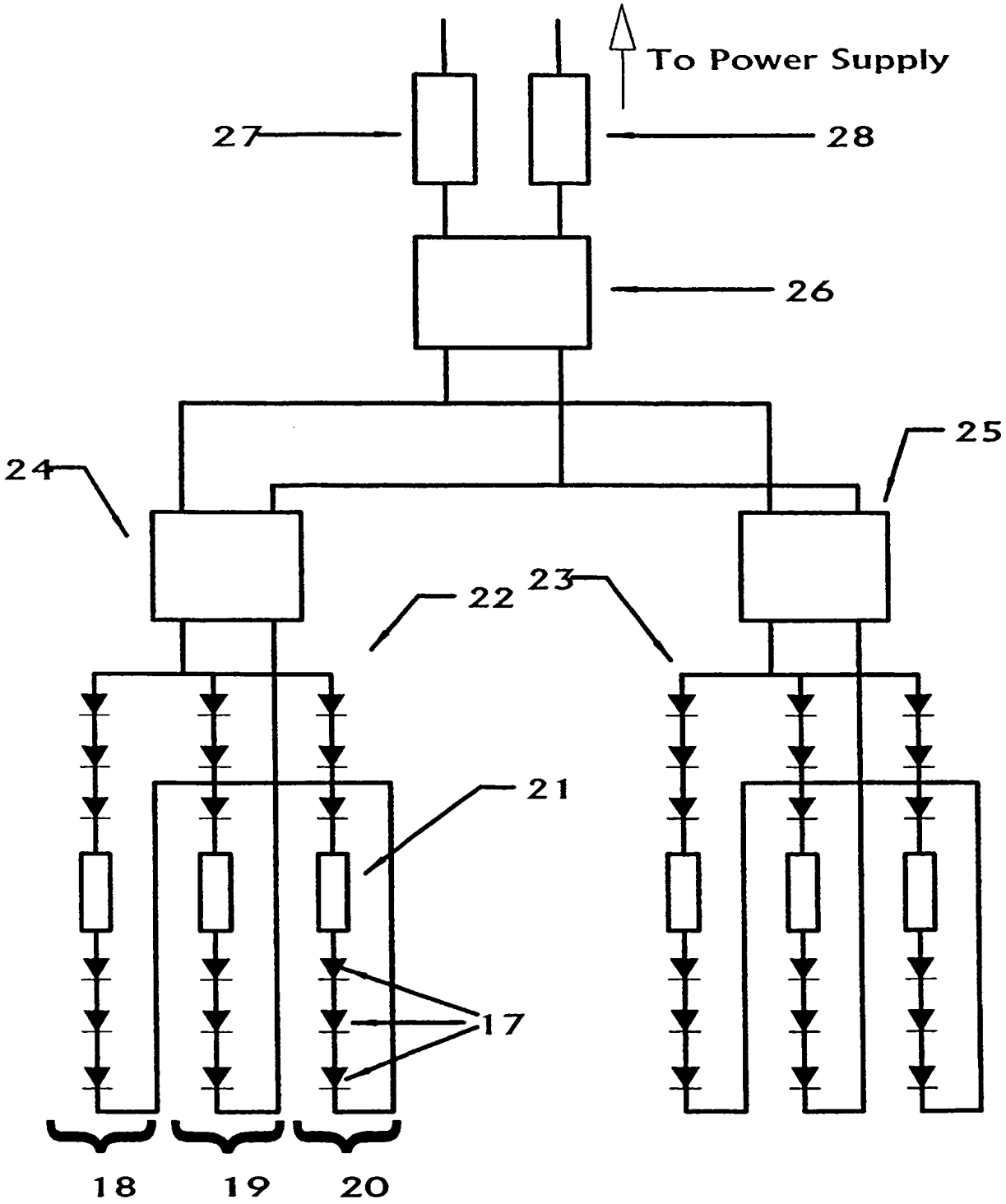

Figure 4

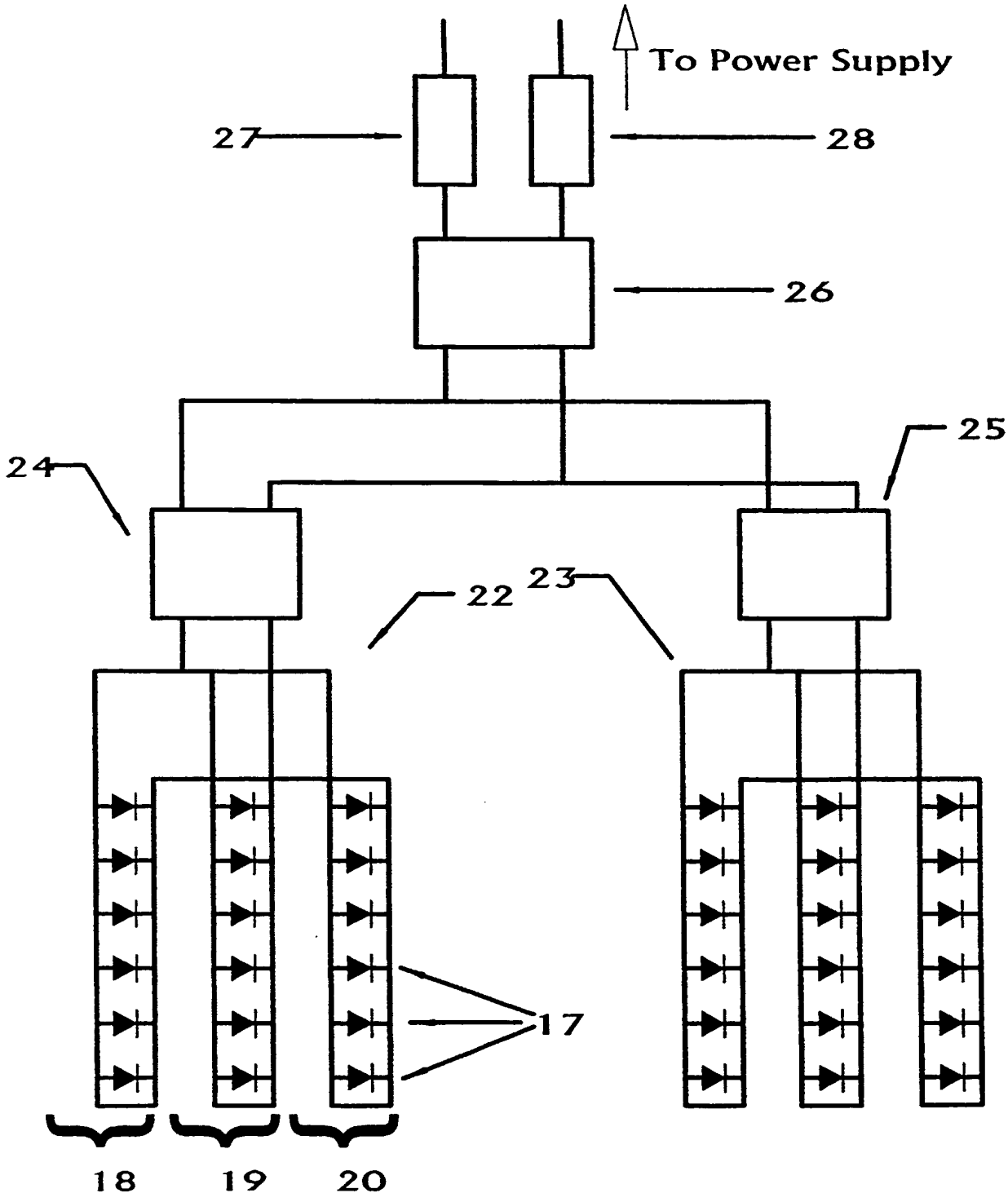

Figure 5

LED LIGHTING UNIT

The present invention relates to a lighting unit using LEDs (Light Emitting Diodes). The lighting unit is particularly, but not exclusively, useful for emergency lighting applications.

LEDs comprise semiconductor diode chips that emit light when their energy levels change. In the past, LEDs were mainly used for applications such as status indicator lights, but recent advances in LED technology have increased LED light output to such an extent that they are potentially useful in more general lighting applications. As LEDs have a much longer lifetime than incandescent lighting devices they may be particularly suitable for critical applications such as emergency lighting.

It is an object of the invention to provide a lighting unit utilising LEDs. It is a further object of the invention to provide a lighting unit that is particularly suitable for emergency purposes. It is a particular object of the invention to provide a lighting unit that will continue to operate despite the failure of one or more components.

According to the present invention there is provided a lighting unit comprising an array of LEDs.

Advantageously the unit may incorporate one or more current-limiting resistors. Alternatively or in addition, the unit may incorporate one or more voltage regulators. Similarly, the unit may incorporate short circuit protection and/or thermal overload protection. Preferably, a bridge rectifier is provided so as to provide current of the correct polarity to the LEDs.

Further advantageously, electrical connections to the array are provided by means of a connection block made of a high-temperature withstanding material. Preferably the connection block comprises ceramic material.

According to a first embodiment the array may comprise two or more groups of LEDs connected so that in the event of the failure of one group the or each further group will continue to operate. Preferably, each group comprises two or more cells of LEDs connected so that in the event of the failure of one cell within a group, the group as a whole will continue to operate. Advantageously, the groups of cells are connected in parallel to form the array. Preferably, each group of cells is provided with a voltage regulator. Particularly preferably, a voltage regulator may be connected across the common inputs of each group of cells.

According to a preferred realisation of the first embodiment, each cell comprises a plurality of LEDs connected in series, the cells being connected in parallel to form a group of cells. Advantageously, each cell may comprise a current-limiting resistor.

According to an alternative realisation of the first embodiment, each cell may comprise a plurality of LEDs connected in parallel, the cells being further connected in parallel to form a group of cells.

Preferably, each LED consists of an illumination portion and a connection portion, the array of LEDs being arranged substantially on a first plane with the illumination portion of the LEDs projecting from one side of the plane so as to provide a substantially planar lighting surface. Advantageously, each LED has an axis of illumination, the LEDs being arranged so that their axes extend outwards from the first plane.

According to a second embodiment of the invention, the LEDs within an array are arranged so that their axes of illumination diverge so as to increase the breadth of illumination of the array. Advantageously, each LED is arranged so that its axis of illumination is angled outwardly with respect to its immediate neighbour which is closer to

the centre of the array. Conveniently, the angle of divergence between the illumination axis of each LED and that of its immediate neighbour is in the range from 4 to 8 degrees, preferably approximately 6 degrees.

Preferably, the LEDs are arranged in a series of concentric bands substantially along the first plane. Further preferably, the axis of illumination of each band of LEDs is angled outwards with respect to the axis of illumination of an adjacent band closer to the centre of the array. Conveniently, the angle of divergence between the illumination axis of each band and that of its immediate neighbour is in the range from 4 to 8 degrees, preferably approximately 6 degrees.

For a better understanding of the present invention and to show more clearly how it may be carried into effect reference will now be made, by way of example, to the accompanying drawings in which:

Figure 1 shows the front face of a lighting unit according to the present invention;

Figure 2 shows the rear face of a lighting unit as shown in Figure 1;

Figure 3 is a diagrammatic representation of a cross-section through the centre of the LEDs shown in Figures 1 and 2;

Figure 4 is a circuit diagram showing a preferred embodiment of the present invention; and

Figure 5 is a circuit diagram showing an alternative embodiment of the present invention.

Figure 1 shows a lighting unit 1 according to the present invention. The unit 1 comprises a circular housing 2 to which is mounted an array of LEDs 3, 4, 5. The unit is adapted so that in use it can be recessed into a surface (e.g. a ceiling, not shown), the rear of the unit projecting through the surface and bearing spring-loaded clips 6 which in use serve to secure the unit 1 to the rear of the surface. The LEDs 3, 4, 5 are arranged in concentric circles.

Figure 2 shows the rear of the unit 1 shown in Figure 1. The circular housing 2 has an inner flange 7 which projects backwards and in use passes through the surface (not shown). The flange 7 has two mounting brackets 8 each bearing a spring-loaded clip 6. To the rear of the unit is also mounted a ceramic connector block 9 provided with electrical connectors (not shown) by means of which power may be supplied to the lighting unit. Wires 10, 11 join the

connector block to the electronic circuitry controlling the LED arrays (see Figures 4 and 5). The connector block 9 and other components are mounted to the unit by suitable means, such as a settable resin material 12.

Figure 3 is a diagrammatic representation of a cross-section through the centre of the LED array shown in Figures 1 and 2. The LEDs are disposed in concentric rows as shown in Figure 1. The axis of illumination 13 of the central LED 3 is shown generally perpendicular to a mounting substrate 16. The axis of illumination 14 of the immediate outer neighbour 4 of the central LED 3 is splayed outward by an angle in the range from 4 to 8 degrees, preferably approximately 6 degrees, with relation to the axis 13 of the central LED 3, as are the axes of illumination of all LEDs in that concentric row. Similarly the next concentric row of LEDs consists of LEDs (e.g. 5), the axis of illumination 15 of which is splayed outward by an angle in the range from 4 to 8 degrees, preferably approximately 6 degrees, with relation to the previous axis 14. Although parallel LEDs would suffice for example in high rooms such as cinemas or in other applications which require narrow beams of light, such as for guidance purposes, for general lighting requirements, and in particular for emergency lighting, a pool of light is required, and this is advantageously realised by splaying the LEDs as discussed.

Figure 4 is a circuit diagram showing a preferred embodiment of the invention. Figure 4 shows a number of LEDs 17 arranged in cells, e.g. 18, 19, 20, of six LEDs each. Each cell is provided with a current-limiting resistor 21. The cells are arranged in two groups 22, 23, each of three cells. Each group is provided with a voltage regulator 24, 25. The LEDs within each cell are connected in series, the cells within each group being connected in parallel and the two groups being connected across the terminals of a bridge rectifier 26 connected to power supply terminals (not shown). The bridge rectifier is provided to render the LEDs insensitive to the manner in which the unit is connected to the power supply. In the absence of such a rectifier the unit would not work unless connected to the correct (positive or negative) line of the DC supply. The unit is generally powered by a 24 volt DC supply but other supplies (generally DC) can be used.

The unit is also provided with a short circuit protection device 27 and a thermal overload protection device 28. These devices prevent damage to the power supply in the event of damage to the unit. Thus, one particular unit may be disabled but the lighting system as a whole will continue to function.

The particular arrangement of cells and groups allows the unit to continue working in the event of partial failure. Failure of an LED means that only the cell associated with that LED would fail. Failure of a voltage regulator means that only the cells associated with that regulator would fail. This inbuilt level of redundancy allows the unit to fulfil its purpose even if components fail or are damaged.

Figure 5 shows another embodiment of the present invention. The arrangement of Figure 5 differs from that of Figure 4 in that, within a cell, the LEDs (e.g. 17) are arranged in parallel rather than in series. No current-limiting resistor is required in this case.

Although it is advantageous to arrange the LEDs concentrically as shown in Figures 1 and 2 above, this is not a requirement. It would also be possible to arrange the LEDs in a rectangular array of rows, each row being splayed outwardly with respect to its neighbour.

It is advantageous to provide the connector 9 of a high-temperature resistant material, such as ceramic. This is because, in the event of a fire, a plastics connector would melt or burn and would interrupt the electrical supply to all the other units. With a ceramic connector, the particular unit may be damaged or destroyed, but the connector will

still function as an insulator and will maintain electrical integrity and pass power to the other units.

Units according to the present invention have been tested and have been shown to provide useful levels of light. Electromagnetic emission tests have further shown that the units are inherently safe and should not interfere with electrical equipment. This is very important in many applications such as in hospitals.

CLAIMS

1. A lighting unit comprising an array of LEDs.

2. A lighting unit as claimed in claim 1 and incorporating one or more current-limiting resistors.

3. A lighting unit as claimed in claim 1 or 2 and incorporating one or more voltage regulators.

4. A lighting unit as claimed in any preceding claim and incorporating short circuit protection.

5. A lighting unit as claimed in any preceding claim and incorporating thermal overload protection.

6. A lighting unit as claimed in any preceding claim, wherein a bridge rectifier is provided so as to provide current of the correct polarity to the LEDs.

7. A lighting unit as claimed in any preceding claim, wherein electrical connections to the array are provided by means of a connection block made of a high-temperature withstanding material.

8. A lighting unit as claimed in claim 7, wherein the connection block comprises ceramic material.

9. A lighting unit as claimed in any preceding claim, wherein the array comprises two or more groups of LEDs connected so that in the event of the failure of one group the or each further group will continue to operate.

10. A lighting unit as claimed in claim 9, wherein each group comprises two or more cells of LEDs connected so that in the event of the failure of one cell within a group, the group as a whole will continue to operate.

11. A lighting unit as claimed in claim 10, wherein the groups of cells are connected in parallel to form the array.

12. A lighting unit as claimed in claim 10 or 11, wherein each group of cells is provided with a voltage regulator.

13. A lighting unit as claimed in claim 12, wherein a voltage regulator is connected across the common inputs of each group of cells.

14. A lighting unit as claimed in any one of claims 10 to 13, wherein each cell comprises a plurality of LEDs connected

in series, the cells being connected in parallel to form a group of cells.

15. A lighting unit as claimed in any one of claims 10 to 14, wherein each cell comprises a current-limiting resistor.

16. A lighting unit as claimed in any one of claims 10 to 15, wherein each cell comprises a plurality of LEDs connected in parallel, the cells being further connected in parallel to form a group of cells.

17. A lighting unit as claimed in any preceding claim, wherein the LEDs within an array are arranged so that their axes of illumination diverge so as to increase the breadth of illumination of the array.

18. A lighting unit as claimed in claim 17, wherein each LED is arranged so that its axis of illumination is angled outwardly with respect to its immediate neighbour which is closer to the centre of the array.

19. A lighting unit as claimed in claim 18, wherein the angle of divergence between the illumination axis of each LED and that of its immediate neighbour is in the range from 4 to 8 degrees

20. A lighting unit as claimed in claim 19, wherein the angle of divergence is approximately 6 degrees.

21. A lighting unit as claimed in any preceding claim, wherein each LED consists of an illumination portion and a connection portion, the array of LEDs being arranged substantially on a first plane with the illumination portion of the LEDs projecting from one side of the plane so as to provide a substantially planar lighting surface.

22. A lighting unit as claimed in claim 21, wherein each LED has an axis of illumination, the LEDs being arranged so that their axes extend outwards from the first plane.

23. A lighting unit as claimed in claim 21 or 22, wherein the LEDs are arranged in a series of concentric bands substantially along the first plane.

24. A lighting unit as claimed in claim 23, wherein the axis of illumination of each band of LEDs is angled outwards with respect to the axis of illumination of an adjacent band closer to the centre of the array.

25. A lighting unit as claimed in claim 24, wherein the angle of divergence between the illumination axis of each

band and that of its immediate neighbour is in the range from 4 to 8 degrees.

26. A lighting unit as claimed in claim 25, wherein the angle of divergence is approximately 6 degrees.

27. A lighting unit substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

Application No: GB 0030466.7 **Examiner:** Dr Jonathan Corden
Claims searched: 1-26 **Date of search:** 28 March 2002

Patents Act 1977
Amended Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): F4R (RGA, RL, RS)

Int Cl (Ed.7): F21K 7/00, F21L 2/00; F21S 2/00; F21V 23/00

Other: Online: WPI, EPODOC, PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2337645 A	(AVIMO) see figs, page 3 lines 12-20 and page 8 lines 1-23	1-3, 9, 17 at least
X	GB 2335308 A	(L.F.D LIMITED) see figs, page 1 line 18-page 2 line 7, page 4 line 1-6	1-4, 7-11, 13, 14, 21, 22 at least
X, Y	GB 1574387 A	(BOURBLON) see figs, page 1 lines 64-97	X:1, 3, 9-11, 13, 14, 17, 21-23 at least Y: 24
X	US 5446440 A	(GLEASON et al) see figs, column 6 lines 32-45 and column 7 lines 3-40	1-6, 9-11, 13, 14, 21 at least
X, Y	US 4654629 A	(BEZOS et al) see figs, column 2 line 52 - column 3 line 8	X: 1, 2, 9, 21, 22 Y: 24
X	US 4298869 A	(OKUNO) see figs, column 2 lines 13-63	1-3, 9-12, 14, 15, 21, 22

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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Date of search: 28 March 2002

Category	Identity of document and relevant passage	Relevant to claims

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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